Betty and Bobtail at Pine-Tree Farm. By Lilian Gask. Pp. 224. (London: G. G. Harrap and Co., Ltd., 1920.) 6*s.* net.

We suppose that a book by this well-known author requires no commendation, but perhaps an appreciation in these pages may have a peculiar value. The story of a little girl's visit to a farm and what she saw of dog and sheep, weasel and vole, bat and eagle, and other creatures—it is not a work of science, of course, but a work of art; and how it is done who shall say? We could tell the same story, but no child would turn an ear. One must have the secret of the Pied Piper. It seems clear, however, that part of the success of the book must be due to its truthfulness—for the natural history seems all right, except a tale about golden eagles hunting the deer in Scotland. Another part of the success of the book must be due to restraint in giving information, for many books for young folks fail utterly in their Sandford-and-Mertonism. The boy explaining why bats are not birds would have been a bore if he had said another word, but he stops just in time. Goethe said something about this sort of thing! The rest of the attractiveness of the book is due to the art of the writer. We should add, however, that the coloured illustrations by Miss Helen Jacobs are charming, and the book is beautifully printed. We commend it heartily for young children.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Disintegration of Elements by α-Particles.

In earlier papers one of us has stated that long-range particles which can be detected by their scintillations on a zinc sulphide screen are observed when α-particles pass through air or nitrogen, but not through oxygen or carbon dioxide. From the deflection of these particles in a magnetic field it appeared that they were charged hydrogen atoms, indicating that some of the nitrogen atoms were disintegrated by an intense collision with an α-particle.

In these preliminary experiments it was difficult to get definite information as to the range of these particles from nitrogen, and so to compare them with the H atoms set in motion by the collisions of α-particles with ordinary hydrogen. Recently, improvement of the optical conditions has made the counting of such weak scintillations much easier and more certain. We have been able to show definitely that the H atoms from nitrogen have a greater range than the H atoms from hydrogen, the ratio being about 1·4 to 1. For example, the H atoms liberated by α-particles of range 7 cm. from hydrogen or any hydrogen compound have a maximum range corresponding to 29 cm. of air; while those from nitrogen have a range of 40 cm. This result shows that these particles cannot possibly arise from any hydrogen contamination.

This observation has opened the way to a series of experiments on other elements. The material under examination, in the form either of gas or of a thin film of element or oxide, is exposed to the α-rays of radium C. Observation of the number of scintillations is made through a thickness of mica corresponding to a distance of 32 cm. of air, so that the results are quite independent of the presence of hydrogen or any hydrogen compound in the material.

In this way we have obtained definite evidence that long-range particles are liberated from boron, fluorine, sodium, aluminium, and phosphorus, in addition to nitrogen.

The numbers observed from boron and sodium are much smaller than those from the other elements mentioned.

The following elements showed very little, if any, effect at an absorption corresponding to 32 cm. fair, viz. lithium, beryllium, carbon, oxygen, magnesium, silicon, sulphur, chlorine, potassium, calcium, titanium, manganese, iron, copper, tin, and gold.

The gases oxygen, carbon dioxide, and sulphur dioxide were examined at absorptions of less than 32 cm. fair, and no trace of these particles was observed. We have not yet examined whether any of the other elements give rise to particles of maximum range less than 32 cm.

The particles liberated from all the first-mentioned elements have a maximum range of at least 40 cm. in air. In particular, the range of the particles from aluminium is surprisingly great, and certainly not less than 80 cm.

While we have no experimental evidence of the nature of these particles except in the case of nitrogen, it seems likely that the particles are in reality H atoms liberated at different speeds from the elements. Assuming that the law connecting range and velocity of the particles is the same as for the α-particle, it follows that the energy of the particle from aluminium of the maximum range of 80 cm. is about 25 per cent. greater than the energy of the incident α-particle.

It is of interest to note that no effect is observed in "pure" elements the atomic mass of which is given by $4n$, where n is a whole number. The effect is, however, marked in many of the elements the mass of which is given by $4n+2$ or $4n+3$. Such a result is to be anticipated if atoms of the $4n$ type are built up of stable helium nuclei and those of the $4n+a$ type of helium and hydrogen nuclei.

It should also be mentioned that no particles have so far been observed for any element of mass greater than 31. If this proves to be general, even for α-particles of greater velocity than those of radium C, it may be an indication that the structure of the atomic nucleus undergoes some marked change at this point; for example, in the lighter atoms the hydrogen nuclei may be satellites of the main body of the nucleus, while in the heavier elements the hydrogen nuclei may form part of the interior structure.

Until accurate data are available as to the effect of velocity of the α-particles on the number, range, and distribution of the liberated particles, it does not seem profitable at this stage to discuss the possible mechanism of these atomic collisions which lead to the disintegration of the nucleus.

E. Rutherford.
J. Chadwick.

Cavendish Laboratory, February 26.

The Atomic Volume of Isotopes.

At the discussion on isotopes at the Royal Society on March 3 the question was raised as to within what limits of accuracy the conclusion is justified that the atomic volume of the various isotopes of lead is constant, and the following collected results

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may therefore be of interest. There are two sets of data. In one the density and atomic weight of lead from thorite have been compared with the values of ordinary lead, and in the other a similar comparison has been made for the lead derived from two uranium minerals. These two sets, of course, cannot be compared together, as the densities of specimens are comparable only when they have been prepared under identical conditions. With due attention to this point the relative densities are, in the case of lead, capable of determination to a very high degree of accuracy.

In the first set of data (Nature, February 4, 1915) the density determinations agreed in the case of three determinations on 73 grams of ordinary lead to within eight units, and in the case of two determinations on 65 grams of thorite lead to within four units in the fourth place of decimals. The first two values of the atomic weights in the following table are single determinations by a modification of Stas's method, the lead being converted into chloride, *via* the nitrate, in a quartz vessel without transference, and the ratio Pb : $PbCl_2$ determined. The third value is that obtained by O. Hönigschmid in Vienna on another fraction of the same thorite lead used in the density determination by the silver titration method from four determinations of the ratio $PbCl_2$: 2Ag and four of $PbCl_2$: 2AgCl, and the probable error is given as ±0·014 (*Zeitsch. Elektrochem.*, 1917, vol. xxiii., p. 161). The second set of data is that of T. W. Richards and C. Wadsworth (Journ. Amer. Chem. Soc., 1916, vol. xxxviii., pp. 221 and 1658). The atomic weights are also by the silver titration method. The value 207·20 for the atomic weight of ordinary lead has also been obtained by G. P. Baxter and F. L. Grover (Journ. Amer. Chem. Soc., 1915, vol. xxxvii., p. 1027), and the value 207·18 by O. Hönigschmid and Mlle. S. Horovitz (*Monatsh.*, 1915, vol. xxxvi., p. 355) by similar methods. (Compare also Ann. Rep. Chem. Soc., 1916, vol. xiii., p. 247.)

Variety of lead.	Atomic weight.	Density at 20°.	Atomic volume.	Difference from mean
Ordinary	207·199	11·3465	18·2619	+0·0009
Ceylon thorite... ...	207·694	11·3760	18·2572	−0·0038
	207·77		18·2639	+0·0029
		Mean	18·2610	
Ordinary	207·20	11·337	18·2765	−0·0026
Australian uranium ore	206·34	11·288	18·2796	+0·0005
Norwegian cleveite ...	206·085	11·273	18·2813	+0·0022
		Mean	18·2791	

The differences in the atomic volume are thus exceedingly small, and, moreover, they are not systematic. Rejecting the single determination of the atomic weight of thorite lead, it appears that ordinary lead with the intermediate atomic weight has an atomic volume slightly below that of the others. It seems quite safe to conclude that the atomic volumes cannot differ by so much as three parts in ten thousand and the atomic diameters by so much as one part in ten thousand. Frederick Soddy.

Relativity and the Velocity of Light.

In his article in Nature of February 17 on the general physical theory of relativity Mr. J. H. Jeans refers to recent experiments of Majorana, and his remarks imply that these experiments rendered it "possible to watch the progress of the ripple directly" and to measure the velocity of light in its unidirectional course from source to receiver, with the result that this velocity was shown to be constant. He contrasts these experiments with the original experiments of Michelson and Morley, in which the mean velocity of light in its outward and return journey after its reflection from a mirror was dealt with. As the point in question is a fundamental one, and as a statement to this effect has been made before, I think the matter should not be passed over.

The experiments of Majorana referred to are doubtless those described in *Comptes rendus* (No. 14, tome clxv., 1917, and No. 2, tome clxvii., 1918) designed to show the constancy of the velocity of light relative to the observer when reflected by a moving mirror or when issuing from a moving source. I venture to suggest that these experiments do not bear the interpretation that Mr. Jeans puts upon them, and that the experiment has not yet been devised that will enable a comparison to be made between the velocity of light on its outward and return journeys along the same path, or that will give a measure of the velocity on a single journey. The author of these papers makes no claim to have done this. I fear such an experiment is impossible.

C. O. Bartrum.

32 Willoughby Road, Hampstead,
February 24.

I had not intended to make the statement which Mr. Bartrum considers is implied in my words, and am sorry that in aiming at brevity I appear to have achieved only ambiguity. It need scarcely be said that I agree that no experiment has been, or can be, devised which can measure the velocity of light in any unidirectional course. The impossibility of any such experiment is, in effect, the primary postulate of the theory of relativity.

It is, nevertheless, possible to compare two velocities along the same unidirectional course, and this is what Prof. Majorana claims to have done.

The Michelson-Morley experiment gave us the sum only of the times of two separate journeys—from A (light) to B (mirror) and back from B to A. We cannot even speak of comparing the time on AB with that on BA until we have defined time at B in terms of the time at A. If this is defined in terms of the relativity relation $t' = \beta(t - ux/c^2)$, then the Michelson-Morley experiment is consistent with the two journeys being performed with the same velocity c, and therefore in equal times, but it does not of itself establish equality either of velocity or of time. The additional information provided by the experiments of Majorana does, I believe, enable this equality to be proved.

Consider the problem in terms of an æther and a **FitzGerald-Lorentz** contraction. According to the Michelson-Morley experiment, the time on the double journey is equal to

$$l_0\left(1 - \frac{u^2}{c^2}\right)^{\frac{1}{2}}\left[\frac{1}{c-u} + \frac{1}{c+u}\right] \quad . \quad . \quad . \quad (1)$$

but there is so far no justification for identifying the two terms in this sum with the times of the separate journeys. The distributed expression for the time of the double journey might, in general, be of the form

$$l_0\left(1 - \frac{u^2}{c^2}\right)^{\frac{1}{2}}\left[\frac{1}{c-u+\alpha} + \frac{1}{c+u+\beta}\right] \quad . \quad . \quad (2)$$

where $c+\alpha$, $c+\beta$ are the velocities through the æther on the two journeys. For this to conform to the results of the Michelson-Morley experiment, expressions (1) and (2) must be equal, requiring that

$$\frac{2c+\alpha+\beta}{(c-u+\alpha)(c+u+\beta)} = \frac{2c}{c^2-u^2} \quad . \quad . \quad . \quad (3)$$

Now impose a further velocity v on the whole Michelson-Morley apparatus, so that its velocity through the æther becomes $u+v$. The first result of Majorana (*Phil. Mag.*, vol. xxxv., p. 173) shows

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